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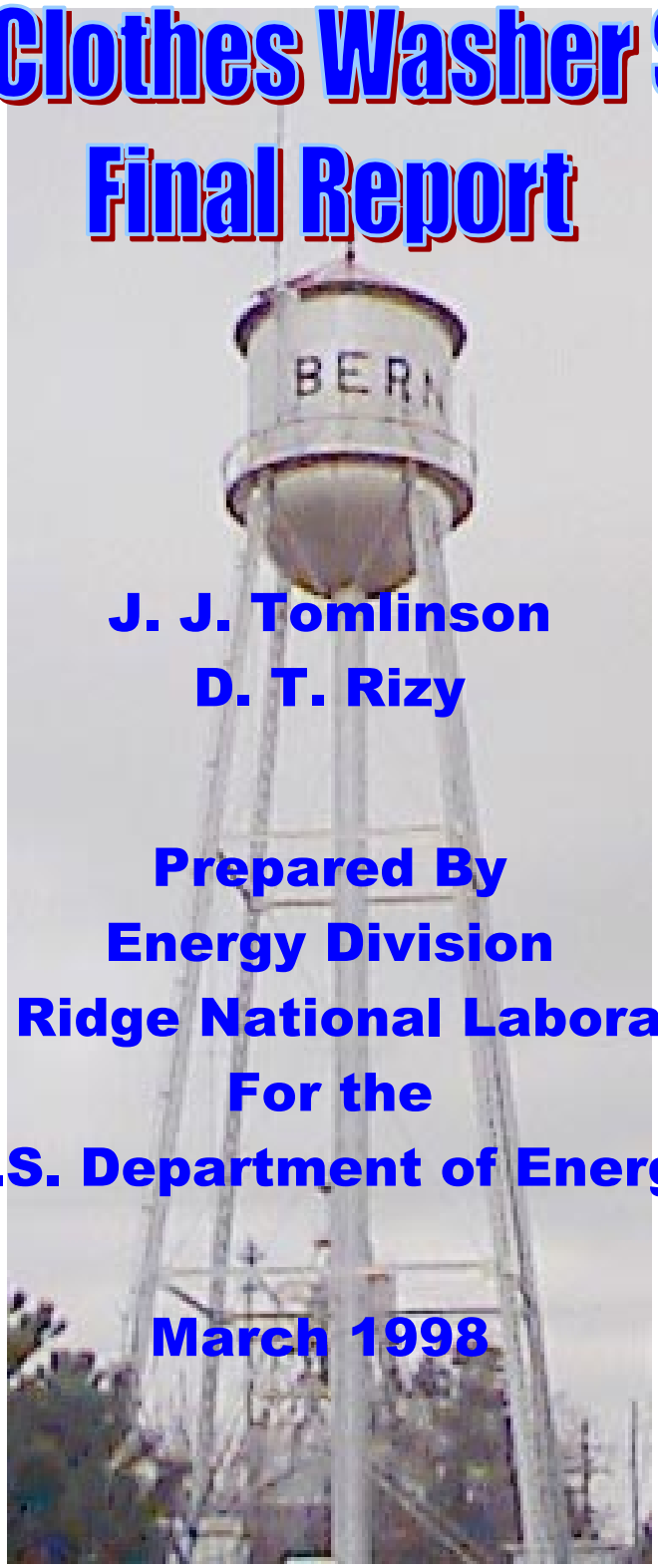
Bern Clothes Washer Study
Final Report



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EXECUTIVE SUMMARY

It comes as a surprise to many that conventional domestic clothes washers use about 40 gallons of water – water weighing more than 300 pounds – to wash a load of clothes which typically may weigh only 7 pounds. This fact combined with knowledge that, on average, U.S. homes wash about one wash load each day, makes automatic clothes washers one of the highest end-uses of water in today's homes. About 35 billion loads of laundry are washed annually in the U.S. and this consumes 2.6% of the total residential energy use[1]. Only a relatively small amount of energy is used by the clothes washer itself to operate the motor and controls. A much larger component is in the energy needed to heat the water used by the washer and in the energy needed to dry clothes once they have been washed. Consequently, washers that have low hot water requirements and have effective spin cycles to remove moisture from the clothing thereby reducing the energy needed by the dryer, tend to be efficient and as long as the laundry throughput (load size) is not compromised, will use less water and energy.

Most clothes washers produced for the U.S. consumer are vertical axis (v-axis) washers with a central agitator. While there are variations, most v-axis washers suspend the clothes in a tub of water for washing and rinsing. As an alternative, the horizontal axis (h-axis) washer tumbles the wash load repeatedly through a small pool of water at the bottom of the tub to produce the needed agitation. This tends to reduce the need for both hot and cold water. The h-axis washer, popular in Europe, has a very limited market share in the U.S. at present. Yet, estimates have shown that a large quantity of energy and water could be saved through the replacement of conventional v-axis washers with the h-axis design. The objectives of this project were:

- to evaluate the energy and water savings of high-efficiency, h-axis washers in a community which has been converted to the new design,
- to demonstrate the findings, and
- to develop information helpful to utilities (energy and water) and others with an eye towards moving the current clothes washer market to higher efficiency options. This project is a key element under the DOE **ENERGY STAR**® market transformation program.

The small town of Bern, Kansas (population approximately 200) was selected for this project. During phase I of the study, 103 clothes washers in the town and surrounding Rural Water District were instrumented so that data on customer profiles, laundry habits, laundry throughput (loads and load weight), and energy and water consumption could be measured. Following a two-month data collection period, all of the washers were replaced by new, h-axis clothes washers, and the experiment continued for an additional three-month period. Overall, detailed data were collected and analyzed on more than 20,000 loads and nearly 70 tons of wash done by all of the participants over a wide range of real-world conditions.

Overall, it was found that the changeover to the h-axis washer reduced the average water consumption from 41.5 gallons/load to 25.8 gallons/load – a water savings of about 38%. The h-axis washer's energy consumption including washer energy and hot water energy fell by 58% due to hot water savings and the impact of a highly efficient motor in the h-axis. The remaining moisture content of damp loads removed from the h-axis washers was, on average, 7% lower than for loads removed from participants' phase I v-axis washers, and this would tend to improve the energy savings from the changeover still further.

[1] "Revolution, Not Agitation: A New Spin on Clothes Washing", *Home Energy*, Vol. 13, No. 6, November/December 1996, pp. 7-8.

The data and subsequent analyses also showed that across all loads, temperature settings, use of detergent and other additives, participants found the cleaning performance of the h-axis technology to be generally superior to their phase I v-axis washer irrespective of its age. Participants seemed to adapt easily to the h-axis design, and laundry habits (average load weights, detergent use, how loads were dried, when loads were washed during the week, wash/rinse temperatures and other factors) remained largely unchanged from phase I to phase II.

These findings demonstrate convincingly that the tumble-action technology (h-axis design) is much more energy and water-efficient than the technology present in clothes washers found in the field today. Taken together, these findings suggest that a changeover to h-axis technology delivers large savings in energy and water to the customer with an improvement in cleaning performance and utility.

ABSTRACT

The U.S. market for domestic clothes washers is currently dominated by conventional, vertical axis washers, which typically require about 40 gallons of water for each load. Although small for an individual load, the fact that 35 billion loads of laundry are washed annually in the U.S. results in a substantial quantity of water and energy use. Although much smaller, today=s market for high-efficiency clothes washers which use much less water and energy is growing albeit slowly as manufacturers are making washers based around tumble-action, horizontal axis designs available, information about their performance and benefits is being developed, and consumers are made aware of these benefits.

To help build awareness of these benefits and to accelerate markets for high-efficiency washers, DOE, under its Energy Star Program and in cooperation with Maytag Appliances, conducted a field-evaluation of high-efficiency washers using Bern, Kansas (population approximately 200) as a test bed. Baseline washer performance data as well as customer washing behavior were obtained from data collected on the existing washers of more than 100 participants in this instrumented study. Following a 2-month initial study period, all conventional washers were replaced by high-efficiency, tumble action washers, and the experiment continued for another 3-month period. Based on measured data from over 20,000 loads of laundry, the impact of the washer replacement on (1) individual customers= energy and water consumption, (2) customers= laundry habits and perceptions, and (3) the community=s water supply and waste water systems were determined and are reported.

GLOSSARY

btu	British thermal unit or 3.6 million joules of energy
C/C	Temperature setting of washer set on cold water wash and cold water rinse
Cold	Cold water use of washer
CRADA	Cooperative research and development agreement
DOE	U.S. Department of Energy
Field	Field data or data collected in a "real world" setting such as a person's home rather than in a tightly-controlled laboratory setting
gal or gals	A measure of water use in gallons. One gallon is equivalent to 3.7854 liters
Gallons/load	Gallons of water use per number of loads by the washer
gpm	Gallons per minute refers to the rate of water use (gallons) over a minute time period
H/C	Temperature setting of washer set on hot water wash and cold water rinse
H-axis	Horizontal-axis washer design in which the axis of rotation of the washer drum is horizontal to the floor on which the washer sits
Hot	Hot water use of washer
I.D.	Identification number or customer number assigned to each participant in the study
kWh	Kilowatt-hour of energy use equivalent to 3413 Btu
Lb or lbs	A pound which is a measurement of weight equal to 2.2046 kilograms
Load or load cycle or cycle	A complete wash/rinse/spin cycle of a washer or a complete cleaning of dirty clothes
ORNL	Oak Ridge National Laboratory, Oak Ridge, Tennessee, managed by Lockheed Martin Energy Research Corp. for the U.S. DOE
oz	Ounce or a unit of weight equal to one-sixteenth of a pound or approximately 28.35 grams.
Phase I	First two months of the Bern Washer Study using conventional v-axis washers
Phase II	Last three months of the Bern Washer Study using new h-axis washers
RMC	Remaining moisture content or moisture remaining in the cleaned laundry after completing the washer's final spin cycle
RWD	Rural water district
SWS	Superwash Saturdays which were two high impact wash days conducted on June 28th for phase I and September 13th for phase II
Total water	Hot plus cold water use of washer combined
TUF	Temperature utilization factor which refers to the percent of loads washed at various wash/rinse washer temperature settings
V-axis	Vertical axis (conventional washer design) in which the axis of rotation of the washer agitator is vertical to the floor
W/C	Temperature setting of washer set on warm water wash and cold water rinse
W/W	Temperature setting of washer set on warm water wash and warm water rinse